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(54) **WAFER SCALE IMAGE SENSOR PACKAGE AND OPTICAL MECHANISM INCLUDING THE SAME**

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H01L 31/0232 (2014.01)
H01L 31/0216 (2014.01)

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CPC ***H01L 31/0232*** (2013.01); ***H01L 31/02162*** (2013.01); ***H01L 31/02327*** (2013.01)

(58) **Field of Classification Search**
CPC H01L 31/0232; H01L 31/02162; H01L 31/02327
USPC 257/98–99, 432
See application file for complete search history.

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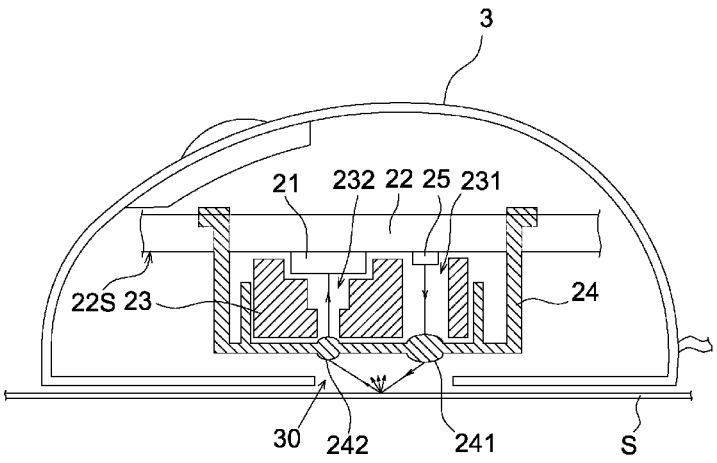
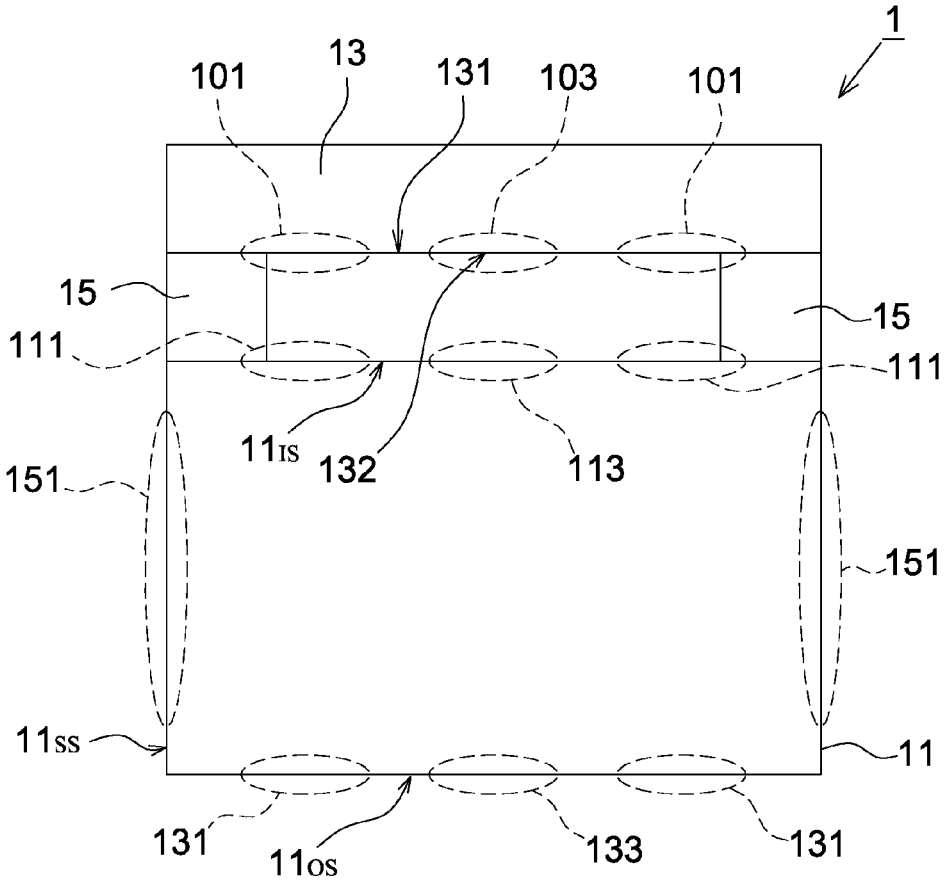
(57) **ABSTRACT**

There is provided an optical mechanism including a substrate, an image sensor chip, a light source, a blocking member and a securing member. The image sensor chip is attached to the substrate and has an active area. The light source is attached to the substrate. The blocking member covers the image sensor chip and has an opening to expose at least the active area of the image sensor chip. The securing member fits on the blocking member to secure the blocking member to the substrate.

15 Claims, 2 Drawing Sheets




1
101
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131
103
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15
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11IS
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11OS
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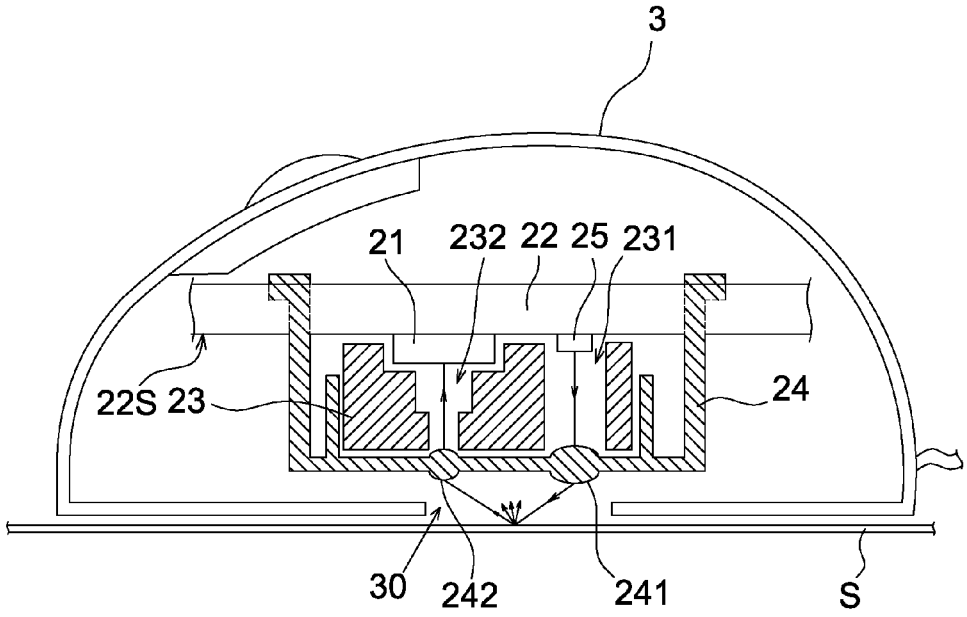
131

FIG. 1


3
21
232
22
25
231
22S
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24
30
242
241
S

FIG. 2

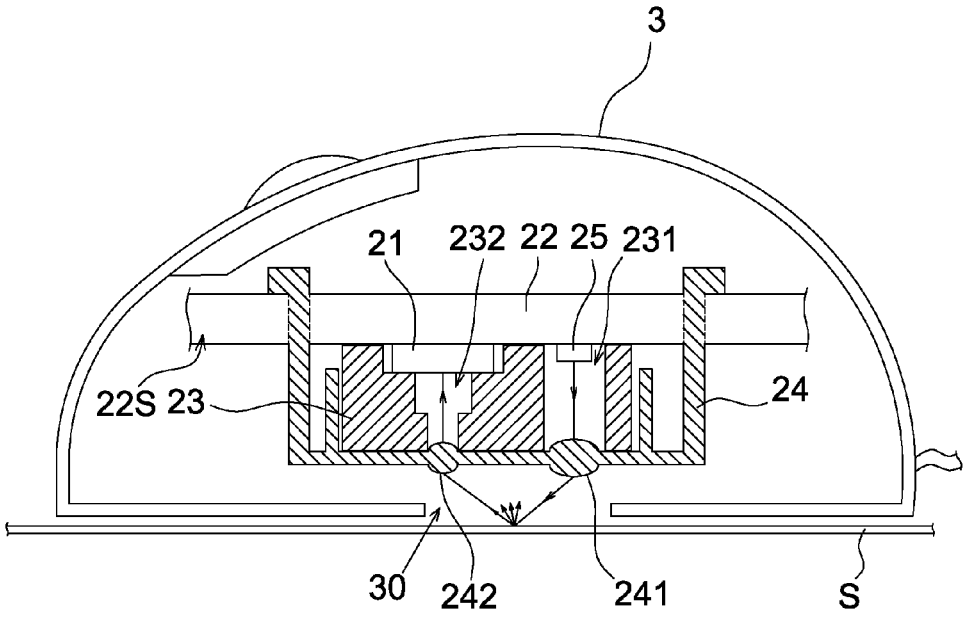
3
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FIG. 3

WAFER SCALE IMAGE SENSOR PACKAGE AND OPTICAL MECHANISM INCLUDING THE SAME

CROSS REFERENCE TO RELATED APPLICATION

This application claims the priority benefit of Taiwan Patent Application Serial Number 100144986, filed on Dec. 7, 2011 and Taiwan Patent Application Serial Number 101120894, filed on Jun. 11, 2012, the full disclosure of which are incorporated herein by reference.

BACKGROUND

1. Field of the Disclosure

This disclosure generally relates to an optical mechanism applied to wafer scale packaging and, more particularly, to an optical mechanism using an image sensor whose semiconductor structure is sealed by transparent materials in wafer scale packaging.

2. Description of the Related Art

Presently, the image sensor chip is manufactured by cutting a die from a silicon wafer and then sealing the die with various packaging technologies such as iDip, LGA or COB technology. These packaging technologies are well known to those skilled in the art and thus details thereof are not described herein.

A common feature of the image sensor chips packaged by the above packaging technologies is that the chips are covered by a black cavity and this is a general type of the chip package nowadays. To image sensor chips, this feature can block ambient light outside the package such that an image sensor chip may be directly applied to various applications, e.g. an optical mouse, after being packaged. The image sensor chip may be directly positioned and fixed at a desired height such that it is able to detect reflected light from a table surface to perform optical navigation.

However, with the development of the semiconductor fabrication technology, the wafer scale packaging has become a mature technology. In the wafer scale packaging, it may use transparent materials, e.g. glass or epoxy, to enclose the die to form a package structure; for example, Chip Scale Package (CSP) technology, Through-Silicon Via (TSV) technology and OPLGA technology may perform the packaging process by using transparent glass or epoxy to seal the die. Therefore in the application of an image sensor chip, this kind of chip package does not have a black cavity such that ambient light outside the image sensor chip may pass through the transparent glass or epoxy to influence the operation of the image sensor chip.

According, there is a need to provide a novel optical mechanism and positioning structure capable of being applied to a wafer scale packaging.

SUMMARY

It is an object of the present disclosure to provide an optical mechanism and positioning structure applied to wafer scale packaging and, more particularly, to a wafer scale image sensor package. As transparent materials, such as glass or epoxy, may be used in wafer scale packaging to enclose an outer surface of the semiconductor circuit, the fabricated wafer scale image sensor package does not include a black cavity to block ambient light. Therefore, the present disclosure provides an optical mechanism and positioning structure configured to tightly secure the packaged chip and the optical

mechanism and/or positioning structure to a substrate, e.g. a printed circuit mother board (PCB), and block or absorb unnecessary light. To image sensor chips configured to detect light and accordingly generate image signals, it is able to effectively prevent the image sensor chips from being interfered by ambient light to degrade the performance.

The present disclosure provides a wafer scale image sensor package including a die, an intermediate layer and a transparent layer. The die has an active area on a sensing surface thereof. The intermediate layer is disposed on the sensing surface and surrounds the active area. The transparent layer is combined to the die through the intermediate layer, wherein a filter layer is formed on at least a partial surface of the transparent layer.

The present disclosure further provides an optical mechanism including a substrate, a wafer scale image sensor package, a light source, a blocking member and a securing member. The wafer scale image sensor package is attached to a front side of the substrate and has an active area. The light source is attached to the front side of the substrate. The blocking member covers the wafer scale image sensor package and has an opening to expose at least the active area of the wafer scale image sensor package. The securing member fits on the blocking member to secure the blocking member to the substrate, wherein the securing member has a first transparent area associated with the light source and a second transparent area associated with the opening of the blocking member.

The present disclosure further provides an optical mechanism of an optical mouse including a substrate, a wafer scale image sensor package, a light source, a blocking member and a securing member. The wafer scale image sensor package and the light source are attached to the substrate. The blocking member covers a part of the wafer scale image sensor package and surrounds the light source. The securing member fits on the blocking member to secure the blocking member to the substrate.

In the optical mechanism of the present disclosure, the first transparent area is configured to allow the light emitted from the light source to emanate from the optical mechanism and reach a reflecting surface; and the second transparent area is configured to allow reflected light from the reflecting surface outside the optical mechanism to pass through and reach the active area via the opening.

In the optical mechanism of the present disclosure, the wafer scale image sensor package has a sensing surface and a backside opposite to each other, wherein the wafer scale image sensor package is mounted to the front side of the substrate via the backside thereof; and a circuit layout is formed on the front side of the substrate to connect to the wafer scale image sensor package.

In the wafer scale image sensor package of the present disclosure, a filter layer of wavelength of interest is coated on at least a partial surface of the transparent layer and/or the sensing surface of the die to allow light of the wavelength of interest to pass through; for example, an infrared and blue filter (B+IR pass filter) allows blue light and infrared light to pass through and an IR pass filter allows infrared light to pass through.

In the wafer scale image sensor package of the present disclosure, at least one reflecting layer, which contains metal components, is coated on at least a partial surface of the transparent layer and/or the sensing surface of the die such that radiation of specific wavelengths may be reflected by the reflecting layer and not enter the image sensor chip.

In the optical mechanism of the present disclosure, a blocking member is provided to cover the wafer scale image sensor package and the blocking member is cooperated with a secur-

ing member. The securing member is fixed on the substrate and directly secures the blocking member at the same time. Therefore, after the securing member is fixed on the substrate, the securing member, the blocking member and the wafer scale image sensor package may keep stable relative positions and the blocking member may prevent ambient light from entering the image sensor chip.

In the optical mechanism of the present disclosure, the wafer scale image sensor package may be directly bonded to the substrate and then the blocking member is covered on the wafer scale image sensor package to keep a relative position. Finally, the securing member is fit on the blocking member and fixed on the substrate. In this manner, the securing member, the blocking member and the wafer scale image sensor package may keep stable relative positions.

In other aspects, the blocking member itself may be directly fixed on the substrate and then the securing member is fit on the blocking member and fixed on the substrate.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, advantages, and novel features of the present disclosure will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

FIG. **1** shows a schematic diagram of the wafer scale image sensor package according to an embodiment of the present disclosure.

FIG. **2** shows a schematic diagram of an optical mechanism and an optical mouse including the optical mechanism according to an embodiment of the present disclosure.

FIG. **3** shows another schematic diagram of an optical mechanism and an optical mouse including the optical mechanism according to the embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE EMBODIMENT

It should be mentioned that in the embodiments and drawings mentioned herein, components irrelevant to the present invention are omitted and the proportional relationship between every component is for illustration purpose but not to limit the actual proportion thereof.

FIG. **1** shows a schematic diagram of the wafer scale image sensor package according to an embodiment of the present disclosure. The wafer scale image sensor package **1** includes a transparent layer **11**, a die **13** and an intermediate layer **15**, wherein the transparent layer **11** may be a glass layer or an epoxy layer, and the intermediate layer **15** is disposed between the die **13** and the transparent layer **11** to function as a buffer and combination between the transparent layer **11** and the die **13**. The die **13** may be a light sensing element which is a semiconductor circuit formed on a silicon wafer. The die **13** has an active area **132** on a sensing surface **131** thereof, wherein the active area **132** may be located substantially at a center area of the sensing surface **131**, but not limited thereto. The intermediate layer **15** is disposed on the sensing surface **131** and surrounds the active area **132**, and preferably the intermediate layer **15** does not block the active area **132**. The transparent layer **11** has an inner surface $\mathbf{11}_{IS}$ facing the die **13**, an exterior surface $\mathbf{11}_{OS}$ opposite to the inner surface $\mathbf{11}_{IS}$ and a lateral surface $\mathbf{11}_{SS}$. In this embodiment, a filter layer and/or a reflecting layer is formed on at least a partial surface of the transparent layer **11** and/or the sensing surface **131** of the die **13** (described later).

In this embodiment, the reflecting layer may be coated on at least one of the locations **101**, **111**, **131** and **151**. The filter layer of wavelength of interest may be coated on at least one of the locations **103**, **113** and **133**. That is, the filter layer may be formed on at least a partial surface of at least one of the inner surface $\mathbf{11}_{IS}$, the exterior surface $\mathbf{11}_{OS}$ and the sensing surface **131** of the die **13**, wherein the filter layer is preferably opposite to the active area **132** of the die **13**; and the reflecting layer may be formed on at least a partial surface of at least one of the inner surface $\mathbf{11}_{IS}$, the exterior surface $\mathbf{11}_{OS}$, the lateral surface $\mathbf{11}_{SS}$ and the sensing surface **131** of the die **13**. As the reflecting layer may contain metal components such as Chromium or others, it is able to effectively limit the light to enter the transparent layer **11** or the die **13** through the area without being coated with the reflecting layer. The filter layer of wavelength of interest and the reflecting layer may be partially overlapped and will not interfere with each other. In this embodiment, the locations **103**, **113** and **133** are effective fields of view of the light sensing element and the effective fields of view are preferably opposite to the active area **132**.

If the reflecting layer has to be formed at a higher temperature, materials of the transparent layer **11** may select those that can tolerate a high temperature, such as the glass material, and the epoxy material is not suitable in this case.

The filter layer of wavelength of interest is configured to allow light of the wavelength of interest to pass through, such as an infrared and blue filter (B+IR pass filter) may allow blue light and infrared light to pass through, and an IR pass filter may allow infrared light to pass through. According to different designs of the chip **1**, different filter layers may be used. For example, in an optical mouse using a light source emitting blue light, the B+IR pass filter may be used; and in an optical mouse using a light source emitting invisible light, the IR pass filter may be used.

For the filter layer having soft material, it is not suitable to be coated on the outer surface of the wafer scale image sensor package **1**; that is, it is not suitable to be coated at the location **133** in order to prevent the filter layer from being damaged or scratched. In this case, the filter layer is preferably formed on the inner surface $\mathbf{11}_{IS}$ of the transparent layer **11** or directed coated on the sensing surface **131** of the die **13**.

The aforementioned filter layer and the reflecting layer may be simultaneously coated on different locations according to different designs of the optical mechanism and the light sensing element such that the reflecting and the absorbing effects may satisfy the design requirement, e.g. coating the filter layer on both locations **103** and **113**.

In another embodiment, if the light to be received is visible light, an IR pass filter may be used to absorb or block the visible light. In this embodiment, the IR pass filter may be coated on the locations coated with the reflecting layer described in the previous embodiment; i.e. at least one of the locations **101**, **111**, **131** and **151**, to be served as an absorption layer. As the IR pass filter can absorb visible light, areas without being coated with the IR pass filter may allow visible light to pass through so as to achieve the object of limiting the penetration of the visible light. In other words, whether a reflecting layer or an absorption layer is formed on the transparent layer **11** and the sensing surface **131** of the die **13** is determined according to the operation property of the light sensing element.

FIG. **2** shows a schematic diagram of an optical mechanism according to the embodiment of the present disclosure, wherein the wafer scale image sensor package **21** (may be referred to a chip **21** hereinafter) is an image sensor chip packaged by wafer scale packaging as shown in FIG. **1**. That is, the chip **21** includes a die **13** and a transparent layer **11**

combined together through an intermediate layer **15**. FIG. **2** shows a schematic diagram of the optical mechanism applied to an optical mouse and thus a light source **25** is further included therein. The light source **25** emits light to pass through the securing member **24** to reach a reflecting surface S, and reflected light from the reflecting surface S passes through the securing member **24** again to reach the chip **21**.

More specifically, the optical mechanism of the present disclosure includes a substrate **22**, a wafer scale image sensor package **21**, a light source **25**, a blocking member **23** and a securing member **24**. The chip **21** is attached to a front side **22**S of the substrate **22** and has an active area **132** (as shown in FIG. **1**). The light source **25** is attached to the front side **22**S of the substrate **22** and emits light going outward from the front side **22**S. The blocking member **23** covers a part of the chip **21**; for example, the blocking member **23** may have an opening **232** to expose at least the active area **132** (FIG. **1**) of the chip **21**. The securing member **24** fits the blocking member **23** and is configured to secure the blocking member **23** to the substrate **22**, wherein the securing member **24** preferably has a first transparent area **241** associated with the light source **25** and a second transparent area **242** associated with the opening **232** of the blocking member **23**. The first transparent area **241** allows the light emitted from the light source **25** to emanate from the optical mechanism and to reach the reflecting surface S. The second transparent area **242** allows reflected light reflected from the reflecting surface S outside the optical mechanism to pass through and to reach the active area **132** of the die **13** through the opening **232** of the blocking member **23**.

The optical mechanism of the present disclosure is generally disposed inside a housing **3**, such as a mouse shell, and the housing **3** may be disposed on a reflecting surface S for being operated by a user and the housing **3** has a bottom hole **30**. The light emitted from the light source **25** illuminates the reflecting surface S through the first transparent area **241** and the bottom hole **30**. The reflected light (including stray light) from the reflecting surface S passes through the bottom hole **30** again and then reaches the active area **132** of the chip **21** through the second transparent area **242** and the opening **232**.

In the present disclosure, most part of the chip **21** is covered by the blocking member **23** such that the light can reach the chip **21** only through the opening **232** of the blocking member **23** upon the chip **21** so as to block unnecessary light to enter the chip **21**. In one embodiment, the blocking member **23** may also surround the light source **25** to prevent the light emitted by the light source **25** from scattering inside the housing **3**. Herein the blocking member **23** may further has a lighting hole **231** configured to allow the light emitted by the light source **25** to emanate from the blocking member **23**. A shape of the blocking member **23** may be designed corresponding to the chip **21** and the light source **25**, and may tightly fit in the securing member **24**. After the securing member **24** is fixed on the substrate **22**, the blocking member **23**, the chip **21** and the light source **25** may keep stable relative positions. It is appreciated that if the blocking member **23** can cover the chip **21** well, the blocking member **23** may not surround the light source **25**.

In the present disclosure, the securing member **24** may be fastened to the substrate **22** using a cantilever structure and at least one hollow may be previously formed on the substrate **22** to allow the cantilever to go through and engage the substrate **22**, and a size of the hollow is formed in a way so that the cantilever can go through and the hollow may not tightly embrace the cantilever. More specifically, if a downward surface of the chip **21** is defined as a horizontal plane herein, by combining the blocking member **23** to the chip **21**, the blocking member **21** and the chip **21** may keep stable relative positions horizontally. After the securing member **24** is fixed on the substrate **22**, as the blocking member **23** is tightly fit in the securing member **24**, the securing member **24**, the blocking member **23** and the chip **21** may keep stable relative positions vertically at a vertical plane which is perpendicular to the defined horizontal plane.

It is clear from FIG. **2** that light guiding structures may be formed in front of the opening **232** of the blocking member **23** (i.e. the second transparent area **242**) and the light source **25** (i.e. the first transparent area **241**) on the securing member **24**. In this embodiment, the light guiding structure associated with the light source **25** is configured to allow the light emitted from the light source **25** to be directed to the reflecting surface S and the light guiding structure associated with the chip **21** is configured to converge the reflected light from the reflecting surface S. Accordingly, the first transparent area **241** and the second transparent area **242** may be lens structures. It is appreciated that a propagation direction of light in FIG. **2** is only exemplary.

In order to show the relative relationship between every element, an explosion-like diagram is shown in FIG. **2** and actually the securing member **24** and the blocking member **23** and/or the blocking member **23** and the chip **21** are designed to be tightly combined together such that the blocking member **23** and the chip **21** may keep stable relative positions by using the securing member **24** (as shown in FIG. **3**), wherein the chip **21** may be bonded to the substrate **22** through solder balls or bonding pads. In addition, the blocking member **23** may select opaque materials of any color, such as a black blocking member.

The substrate **22** mentioned above may be an inflexible substrate such as a PCB substrate and is configured to combine and fix the securing member **24**. Meanwhile, a front side **22**S of the substrate **22** may have a circuit layout to electrically connect to the chip **21**. In addition, the securing member **24** may be fastened to the substrate **22** in other ways, such as a screw may be used to fix the securing member **24** on the substrate **22** so as to keep stable relative positions between every element. In other embodiments, the blocking member **23** itself may be directly fixed on the substrate **22** and then the securing member **24** is fit on the blocking member **23** and fixed to the substrate **22**.

As mentioned above, the optical mechanism may keep the wafer scale image sensor package at a predetermined position and block or absorb ambient light outside the image sensing element so that the image sensing system can operate correctly in the image sensor application. In this manner, the optical mechanism and positioning structure of the present disclosure may be applied to the image sensor chip packaged by wafer scale packaging.

Although the disclosure has been explained in relation to its preferred embodiment, it is not used to limit the disclosure. It is to be understood that many other possible modifications and variations can be made by those skilled in the art without departing from the spirit and scope of the disclosure as hereinafter claimed.

What is claimed is:

1. An optical mechanism, comprising:

a substrate having a front side and a rear side opposite to the front side;

a wafer scale image sensor package attached to the front side of the substrate and having an active area;

a light source attached to the front side of the substrate;

a blocking member attached to the front side of the substrate from a front of the active area of the wafer scale image sensor package to cover the wafer scale image

sensor package, the blocking member comprising an opening to expose at least the active area of the wafer scale image sensor package; and

a securing member fitting on the blocking member from the front of the active area of the wafer scale image sensor package to secure the blocking member to the front side of the substrate, wherein the securing member comprises a first transparent area associated with the light source and a second transparent area associated with the opening of the blocking member, and the securing member has

a first portion engaging the rear side of the substrate,

a second portion extending from the first portion, through a hollow in the substrate, to the front side of the substrate, and

a third portion connected to the second portion and engaging a front side of the blocking member, wherein

the blocking member is sandwiched between the third portion of the securing member and the front side of the substrate.

2. The optical mechanism as claimed in claim **1**, wherein the optical mechanism is applied to an optical mouse.

3. The optical mechanism as claimed in claim **1**, wherein the first transparent area and the second transparent area are lens structures.

4. The optical mechanism as claimed in claim **1**, wherein the blocking member is made of opaque material.

5. The optical mechanism as claimed in claim **1**, wherein the wafer scale image sensor package comprises a die and a transparent layer combined together through an intermediate layer, and a filter layer is coated on at least a partial surface of the transparent layer opposite to the active area.

6. The optical mechanism as claimed in claim **5**, wherein the transparent layer has an inner surface facing the die and an exterior surface opposite to the inner surface, and the filter layer is coated on at least one of the inner surface and the exterior surface.

7. The optical mechanism as claimed in claim **5**, wherein the filter layer is further coated on a sensing surface of the die opposite to the active area.

8. The optical mechanism as claimed in claim **5**, wherein the filter layer is an IR pass filter or an infrared and blue filter.

9. The optical mechanism as claimed in claim **7**, wherein the filter layer is an IR pass filter or an infrared and blue filter.

10. An optical mechanism of an optical mouse, comprising:

a substrate;

a wafer scale image sensor package attached to the substrate;

a light source attached to the substrate;

a blocking member attached to the substrate from a front side of the substrate and covering a part of the wafer scale image sensor package and surrounding the light source; and

a securing member fitting on the blocking member from a same direction in which the wafer scale image sensor package is attached to the substrate to secure the blocking member to the substrate from the front side of the substrate, wherein the securing member has

a first portion engaging a rear side of the substrate, the rear side opposite to the front side,

a second portion extending from the first portion, through a hollow in the substrate, to the front side of the substrate, and

a third portion connected to the second portion and engaging a front side of the blocking member, wherein

the blocking member is sandwiched between the third portion of the securing member and the front side of the substrate.

11. The optical mechanism as claimed in claim **10**, wherein the wafer scale image sensor package comprises a die and a transparent layer combined together through an intermediate layer, and a filter layer is coated on at least a partial surface of at least one of the transparent layer and the die.

12. The optical mechanism as claimed in claim **10**, wherein a reflecting layer is coated on at least a partial surface of at least one of the transparent layer and a sensing surface of the die.

13. The optical mechanism as claimed in claim **11**, wherein a reflecting layer is coated on at least a partial surface of at least one of the transparent layer and a sensing surface of the die.

14. An optical mechanism, configured to prevent ambient light from entering an active area of a wafer scale image sensor package attached to a substrate, which comprises a light source attached thereto, the optical mechanism comprising:

a blocking member attached to the substrate from a front of the active area of the wafer scale image sensor package to cover the wafer scale image sensor package from a front side of the substrate, the blocking member comprising an opening to expose at least the active area of the wafer scale image sensor package; and

a securing member fitting on the blocking member from the front of the active area of the wafer scale image sensor package to secure the blocking member to the substrate from the front side of the substrate, wherein the securing member comprises a first transparent area associated with the light source and a second transparent area associated with the opening of the blocking member, and the securing member has

a first portion engaging a rear side of the substrate, the rear side opposite to the front side,

a second portion extending from the first portion, through a hollow in the substrate, to the front side of the substrate, and

a third portion connected to the second portion and engaging a front side of the blocking member, wherein

the blocking member is sandwiched between the third portion of the securing member and the front side of the substrate.

15. An optical mechanism of an optical mouse, configured to prevent ambient light from entering a wafer scale image sensor package attached to a substrate, which comprises a light source attached thereto, the optical mechanism comprising:

a blocking member attached to the substrate from a front side of the substrate and covering a part of the wafer scale image sensor package and surrounding the light source; and

a securing member fitting on the blocking member from a same direction in which the wafer scale image sensor package is attached to the substrate to secure the blocking member to the substrate from the front side of the substrate, wherein the securing member has

a first portion engaging a rear side of the substrate, the rear side opposite to the front side,

a second portion extending from the first portion, through a hollow in the substrate, to the front side of the substrate, and

a third portion connected to the second portion and engaging a front side of the blocking member, wherein

the blocking member is sandwiched between the third portion of the securing member and the front side of the substrate.

* * * * *